



FOREST PEST CONDITIONS IN WISCONSIN

ANNUAL REPORT 1989

DEPARTMENT OF NATURAL RESOURCES
BOX 7921
MADISON, WISCONSIN 53707

FOREST PEST CONDITIONS IN WISCONSIN ANNUAL REPORT - 1989

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DEPARTMENT OF NATURAL RESOURCES
Division of Resource Management
Bureau of Forestry

ACKNOWLEDGEMENTS

This record of the activities of forest pests and other destructive agents of growing trees in Wisconsin's forest nurseries, plantations, and natural timber areas was made possible by the dedicated work of pest management personnel in each district and at the Forest Pest Management Laboratory in Madison. Department of Natural Resources foresters, other Department field personnel, cooperators in other public agencies and private forest industry contributed valuable assistance in monitoring the forest lands in all classes of forest ownership.

There was a personnel change in the Forest Pest Management program in Wisconsin in 1989. John Trobaugh, Laboratory Technician at the DNR Forest Pest Laboratory, left for a position as nursery manager for Nekoosa Papers, Inc., Port Edwards, Wisconsin.

Preparation of this Annual Report was a result of a team effort involving Steve Katovich, William Kearby, and Shane Weber, DNR District Entomologists who submitted district reports. Jane Cummings Carlson and Dave Hall, Forest Pest Unit, Madison, consolidated the district reports and wrote the final draft using personal computers. Lee Halbrook and Margaret Bemis, Limited Term Employees, prepared the computer-generated and hand-drawn maps, and Katherine Severson, Southern District Program Services, completed the word processing. Final printing was done by the DNR Bureau of Program Services.



Allen J. Prey
Supervisor, Forest Pest Management
June 18, 1990

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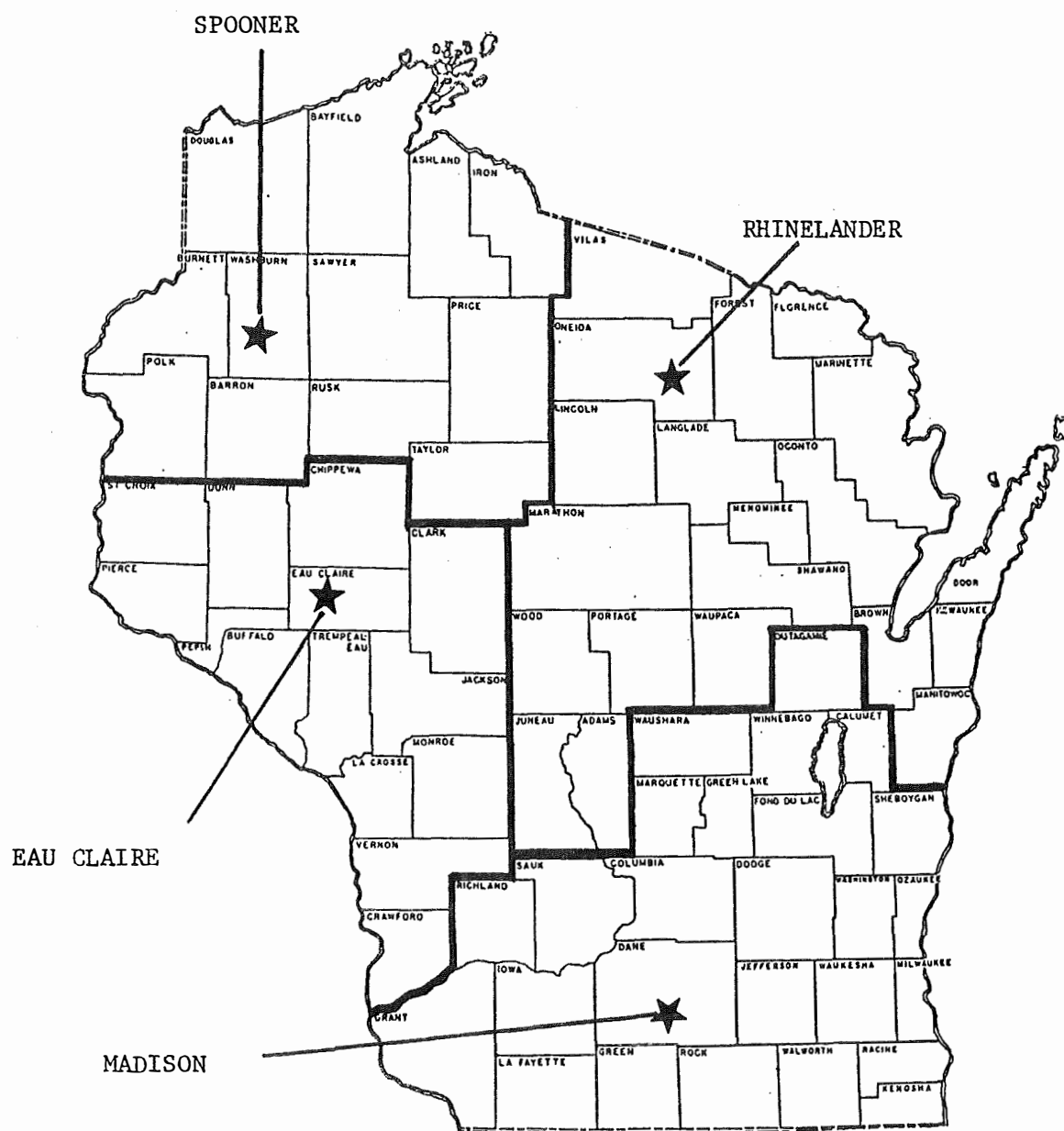


Figure 1. Station locations of Wisconsin Department of Natural Resources District Entomologists and Forest Pest Unit Personnel.

DEPARTMENT OF NATURAL RESOURCES
Forest Pest Management Personnel - December 31, 1989

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INTRODUCTION

This report lists the major insect and disease problems reported on forest land in Wisconsin in 1989. While this report does not list all the insect and disease problems that occurred on forest land, it does highlight major or noteworthy insect infestations, and disease occurrences including abiotic damage to trees.

In 1989, insect and disease detection surveys were conducted on 8.2 million acres and evaluation surveys on another 4.6 million acres. In addition, DNR district entomologists and forest pest staff continued to teach integrated pest management principles to DNR foresters, industrial foresters, and private woodland owners. District forest entomologists and forest pest unit staff provided a wide variety of programs and information on forest pests in 1989. A very successful "Vegetation Management" short course was held February 21-22, 1989, at Wausau for 150 foresters from DNR, USFS, and industry. Forest pest staff lectured at reforestation workshops for woodland owners at Madison in February and at Oshkosh in March.

A one-day training session and field trip on how to identify walnut canker, chestnut blight, and various larch needlecasts was held in March for six plant industry specialists for Wisconsin Department of Agriculture, Division of Trade and Consumer Protection.

Information on drought and pine bark beetle mortality was presented to the Governor's Council on Forestry meeting in Eau Claire on April 19, 1989. Also, the forest pest steering and advisory council members examined pine bark beetle, hemlock mortality and other drought-related problems in Chippewa and Eau Claire counties on June 18, 1989.

Jane Cummings Carlson and Allen Prey presented lectures on forest pathology and IPM at UW-Stevens Point on April 26, 1989.

Information on the status of the oak wilt situation in Marinette County, Wisconsin was presented at the Michigan Society of American Foresters meeting in Menominee County, Michigan in April. Johann Bruhn (Michigan Tech) and Bob Heyd (Michigan DNR) were also on the program discussing the Michigan control program. We are working on an approach to a biologically sound and financially feasible control program within the Menominee River Valley of Michigan and Wisconsin.

The forest pest unit worked on developing an IPM program for Christmas tree producers in Wisconsin. Jane Cummings Carlson, DNR Forest Pathologist, and Brian Jensen, UW-Extension IPM Program Coordinator, met with Christmas tree producers in central Wisconsin to develop and evaluate insect and disease survey methods that can be done by the growers or with their consultants. The forest pest unit participated in the Wisconsin Christmas Tree Producers annual meeting at Wisconsin Dells in July, 1989. The display and diagnostic booth received a lot of interest.

Approximately 100 people were helped with various insect, disease, and weed problems. In addition, Jane Cummings Carlson announced the start-up of Christmas tree pest information on the UW-Extension pest phone. The toll free number was 1-800-236-4264. When dialed, a computer-generated voice replied with the latest Christmas tree pest information. Also, Dave Hall worked up an IPM monitoring and action calendar for a Christmas tree plantation in Columbia County. This action calendar can be adapted for other plantations throughout the state.

Considerable time was spent producing information for the media concerning major forest pests such as the forest tent caterpillar. For example, press releases and television interviews concerning the "Forest Tent Caterpillar and the Friendly Flies" were issued by Bill Kekarby, north central district entomologist.

Forest pest staff participated in a forestry research listening seminar, held by the University of Wisconsin-Madison in Rhinelander and Cable, Wisconsin in June. Approximately 20 leaders from industry, the U.S. Forest Service, and consultants expressed their research needs to Don Field (Associate Dean) and Ron Giese (Chairman, Department of Forestry).

Jane Cummings Carlson and Manfred Mielke (S&PF, U.S. Forest Service, St. Paul, Minnesota) conducted a walnut canker training session for 25 foresters and forest pest personnel from Iowa, Missouri, Illinois, and Minnesota at the Yellow River State Forest in Iowa on May 25, 1989, as part of a regional walnut canker survey. The region-wide processing of walnut canker samples was coordinated by the Wisconsin DNR Pest Unit. A total of 160 walnut cankers were processed in July, 1989 from Wisconsin, Missouri, Michigan, Iowa, and Illinois. Forest pest management staff also surveyed 30 black walnut plantations for canker in southern and southwest Wisconsin. Introduced basswood thrips were also collected at the training session at the Yellow River State Forest, a first report for Iowa.

Jane Cummings Carlson presented information on forestry and forest pathology to 50 high school students at a Natural Resources Career Workshop at the Central Wisconsin Environmental Center, UW-Stevens Point.

Forest pest staff participated in a Wisconsin Society SAF Section Meeting at Rhinelander on June 13 and 14, 1989. Jane Cummings Carlson gave a presentation on insects, diseases, and hazardous trees and helped John Hintz (DNR-Keshena) with an oak wilt presentation. Tom Rausch (DNR volunteer) set up and staffed the DNR Forest Pest exhibit.

An Urban/Wildland Interface Forest Pest Workshop for city, county, extension, DNR, and consultant foresters was held in Eau Claire on June 27, 1989. The session was coordinated and led by Steve Katovich with instruction by Chuck Koval (UW-Extension) and Allen Prey (Wisconsin DNR).

Drought stress, the palmer drought index, and bark beetle management were presented by Bill Kearby at the Wisconsin Paper Council meeting in Wausau and at the Lincoln County Woodland Owners Association meeting in Merrill in June, 1989.

A bark beetle, woodborer, and drought display was exhibited at the Wisconsin State Fair in August, 1989.

Dave Hall participated in a WWOA meeting at Fond du Lac on September 23 and 24, 1989 and staffed a forest pest information booth. Dave also presented information on herbicides at a reforestation workshop at Wisconsin Rapids on September 13 and 14, 1989, and participated in a reforestation-herbicide field tour for DNR foresters in Calumet and Manitowoc counties.

Steve Katovich presented information on bark beetles, blister rust, and white pine weevil at WWOA meetings at Eau Claire in February. He also presented information on pine pest management at a tree farm meeting at LaCrosse in August. Steve conducted a workshop for DNR foresters on "Weed Identification on Conservation Reserve Lands" in August in LaCrosse. He also presented pine and hardwood pest management information at a WWOA meeting at Sparta in October.

Shane Weber, northwest district entomologist, presented information on pine bark beetles at Webb Lake Property Owners Association meeting in July. He also talked to the Spooner Kiwanis Club about hardwood pests. Shane also conducted training sessions for DNR foresters. A pesticide and herbicide update was presented to DNR foresters at Brule, Wisconsin in January. A northern hardwood pest training session was conducted in July at Park Falls and at Gurney, Wisconsin in September.

Jane Cummings Carlson and Bill Kearby conducted a Northern Hardwood Pest Management training session at a DNR hardwood marking camp near Crandon on October 16, 1989. Approximately 30 individuals attended. Jane also conducted a field trip and training session for UW-Forestry students at Tower Hill State Park. She co-taught with Dr. John Gibbs a visiting forest pathologist from England.

Jane Cummings Carlson was selected to serve on the Steering Committee for a regional conference entitled, "Natural Resources/Human Resources: Diversity for Success," to be held at Stevens Point in 1991.

Information on Lyme Disease was provided to a wide variety of individuals and organizations including the editor of Fish Finder magazine. Dave Hall and Jane Cummings Carlson worked with Leigh Klein (UW-Madison) on a three extension leaflets on plantation planning, planting, and maintenance which were published during the winter of 1989-90.

Allen Prey co-chaired, and Dave Hall handled the finances, at a statewide meeting of the Wisconsin Society of American Foresters held at Wisconsin Dells, October 11 through 13, 1989. The theme of the meeting was forest stress and approximately 150 people attended. This meeting covered biological, social and political stress on

Wisconsin's forest resources. In October of 1989, an article, "Integrated Pest Management for Christmas Trees - its time has come," by Jane Cummings Carlson and Bryan Jensen was published in the American Christmas Tree Journal.

Jane Cummings Carlson worked with Dick Camp in developing an IPM Program to control Diplodia shoot blight on red pine seedlings at Wilson Nursery because current control measures of partial removal of infected windbreaks was not working. Also, forest pest staff and forest nursery staff collected native hazelnuts from various locations in Wisconsin and sent them to Oregon State University to be used in an Eastern Filbert Blight Disease Research Program.

Jane Cummings Carlson lectured in December at the Department of Forestry, University of Wisconsin-Madison, on Forest Nursery Diseases.

The forest pest staff and district entomologists also spent a good percentage of their time on pesticide issues. For example, Bill Kearby, north central district entomologist, arranged and participated in an office and field meeting with a Bell Laboratories technical representative and foresters from Consolidated Papers, Inc., to review current technology for the suppression of the meadow vole. He also provided technical assistance on a treated pea seed clean-up near a stream in Langlade County, and provided assistance in clean-up of 2,4-D on fish management lands in Portage County.

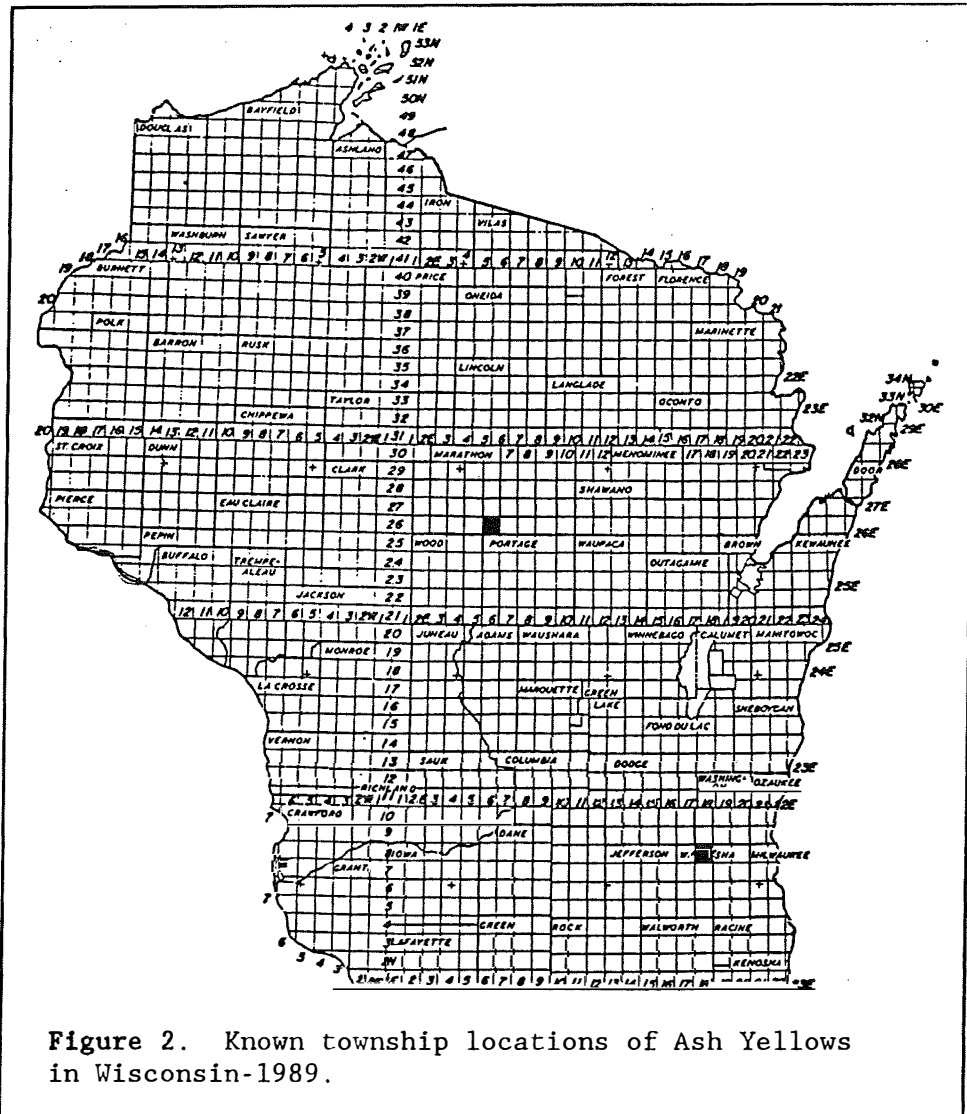
The forest pest staff participated in various national and regional meetings and conferences during 1989. Jane Cummings Carlson attended the American Phytopathological Society in Richmond, Virginia in which she presented a paper titled, "Investigation of Decline and Mortality of Sugar Maple and Other Northern Hardwoods Across a Rain pH Gradient in Wisconsin." Jane was also elected Chair-elect of the APS Forest Pathology Committee.

Jane Cummings Carlson also moderated a session at the National Walnut Council Meeting in Carbondale, Illinois, July 30-August 2, 1989, and was elected Chair of the Protection Committee. Al Prey participated in the combined Western Disease and Insect Work Conferences at Bend, Oregon, September 11 through 14, 1989. He also attended a North American Sugar Maple Decline Project Review Workshop at Montreal on March 29 and 30, 1989. Seven states and two Canadian provinces were represented. Bill Kearby also participated in the North Central Forest Pest Workshop in Winnipeg, Manitoba, Canada during September, 1989.

The forest pest staff and district entomologists participated in a meeting between the U.S. Forest Service and state cooperators in St. Paul during March, 1989. A variety of topics were covered including remote sensing, geographic information systems, Lyme Disease, and drought impact on trees.

ASH

No new counties reported ash yellows in 1989. The two known locations of ash yellows in Wisconsin are shown in Figure 2. A survey is planned for 1990 to determine whether or not the mycoplasma like organism is present in declining green and white ash in Wisconsin's forests.



ASPEN

Aspen Bronzing - Unknown

Samples of symptomatic aspen bronzing leaves were collected from large-tooth aspen and hybrid poplar in Sauk County and from large-tooth aspen in Washburn County. Samples were sent to Agdia, Inc. for testing for the presence of fastidious, xylem-inhabiting bacteria (FXIB). All samples were negative for the FXIB. A problem with testing methods is suspected so samples will be collected again in 1990.

Symptoms were observed in previously unreported

locations in Washburn County (T40N, R13W, Section 31, SENE and T39N, R12W, Section 17, SWSW) and in previously reported T40N, R13W, Section 30, SESW. No new counties reported aspen bronzing (Figure 3).

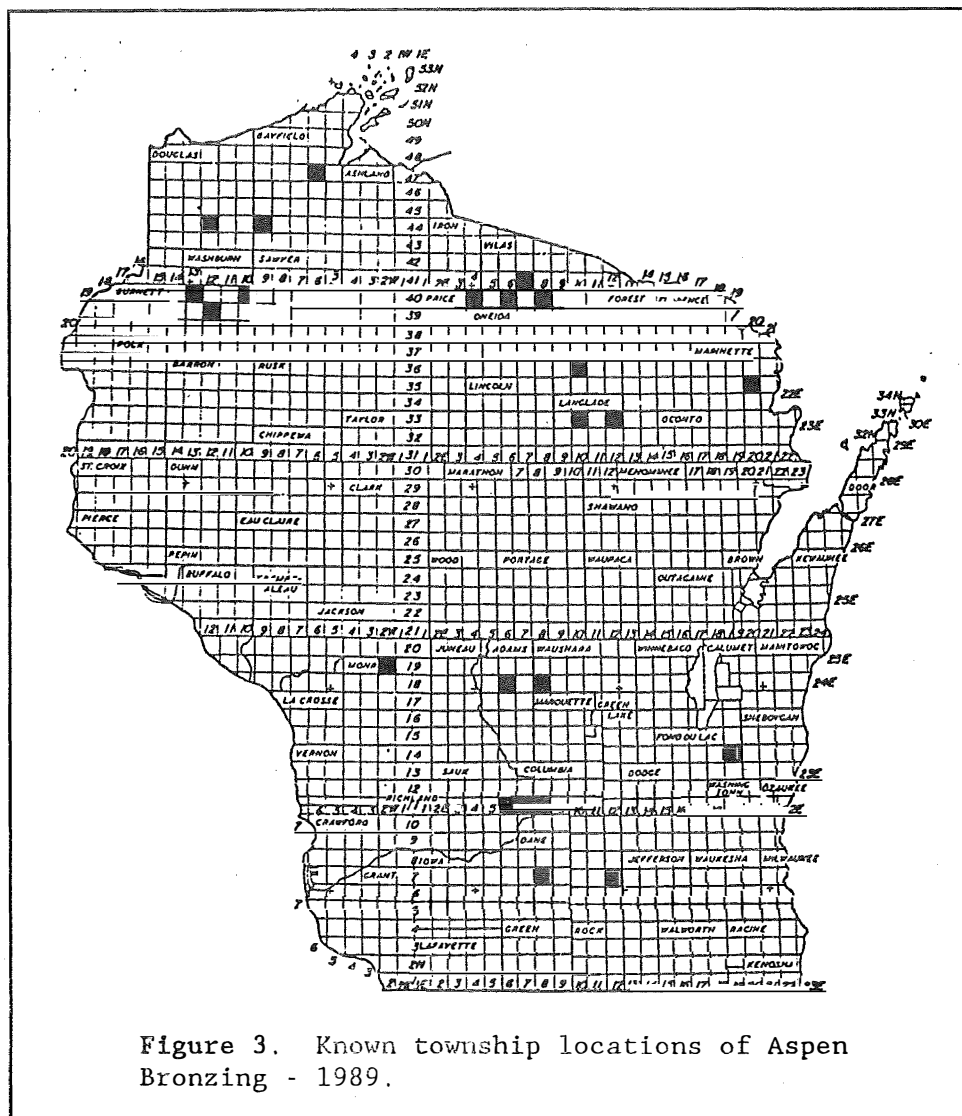


Figure 3. Known township locations of Aspen Bronzing - 1989.

Aspen Blotchminer - *Phyllonorycter tremuloidiella* (Braun)

The outbreak that erupted in 1987 in the northern counties continued to decline. Only very light levels of leaf mining were observed.

Forest Tent
Caterpillar -

*Malacosoma
disstria*
(Hubner)

Widespread heavy defoliation of aspen, birch and oak occurred in several north-eastern and northwestern counties (Figure 4). Hardest hit was Marinette County where the entire aspen timber type in the county, 211,000 acres, was moderately to heavily defoliated.

Parasitic Sarcophagid flies associated with the infestations were very annoying to tourists, especially in the northeastern counties.

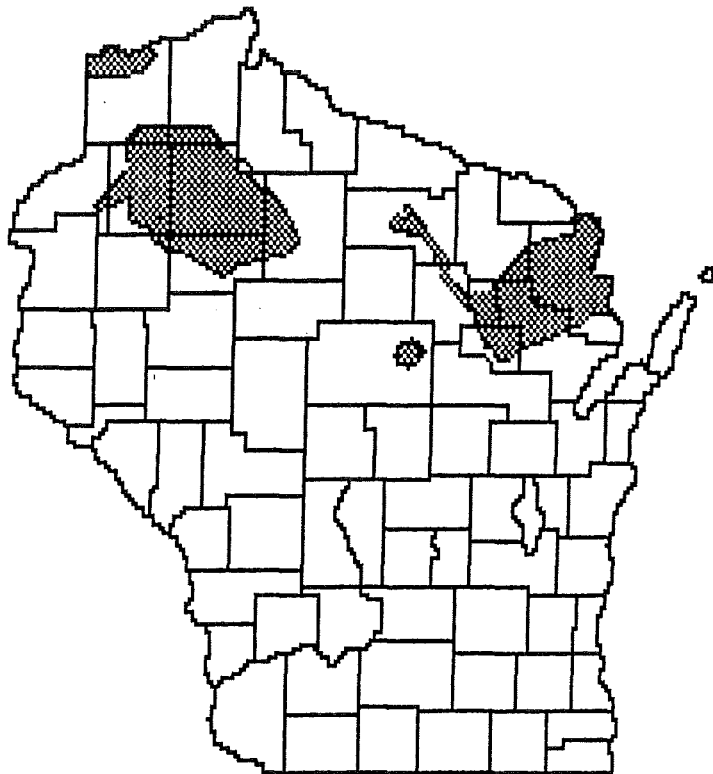


Figure 4. Area of light to heavy defoliation by the Forest Tent Caterpillar - 1989.

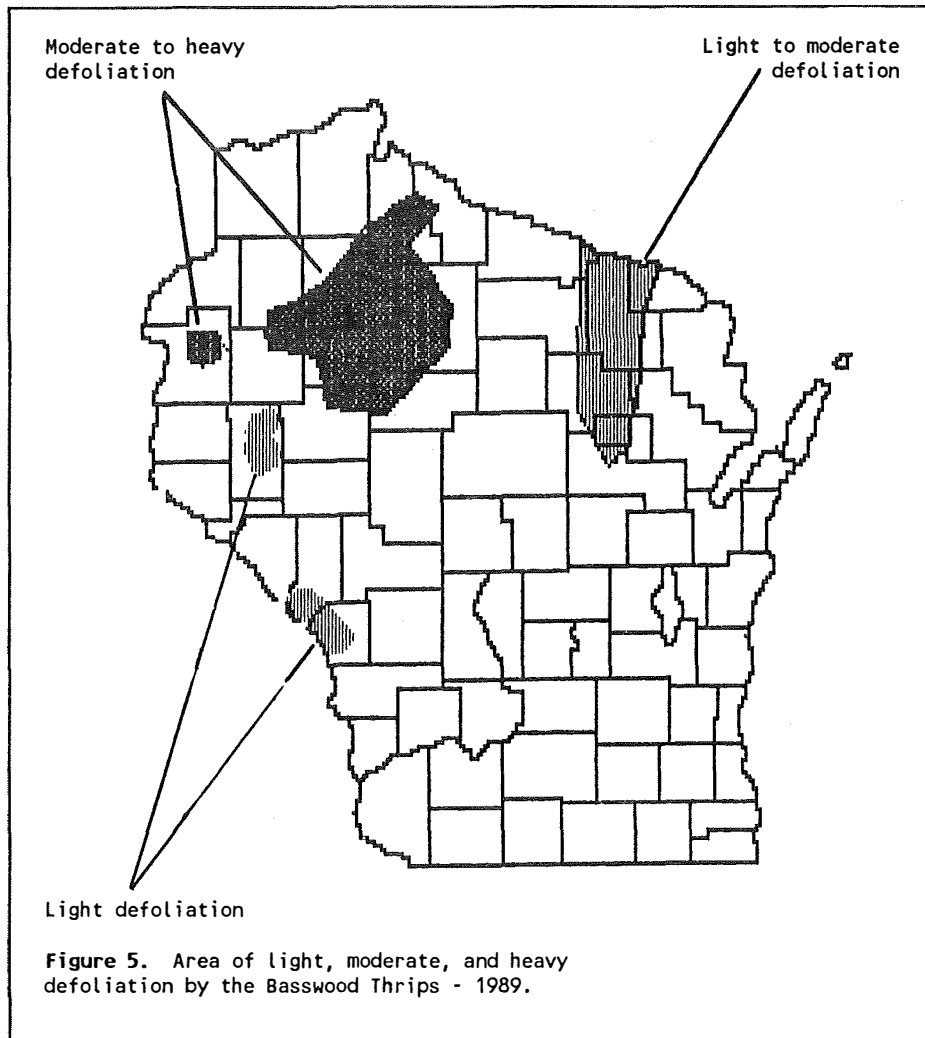
High quality red oak in Menominee County was given foliage protection with aerial applications of two insecticides. The growth regulator, Dimilin was applied to 25,600 acres at a rate of 3 ounces ai plus 1 pint mineral oil in sufficient water to make 1 gallon of formulation per acre. The bacterial insecticide, *Bacillus thuringiensis* was applied to 2,235 acres near water at a rate of 8 BIUs plus sticker and spreader in sufficient water to make one gallon of formulation per acre.

Egg mass surveys in December point to increasing populations in eastern Menominee County and continued heavy populations in Marinette County in 1990. Heavy moth flights in the northwestern counties indicate the potential for widespread defoliation in 1990.

Phenological Notes:

- May 10 Eggs are hatching rapidly in Menominee County and should be 90% hatched by May 14.
- May 31 Larvae promarily in 4th instar.
- June 7 Larvae in 4th instar in northeastern counties.
- June 15 Pupation has begun in northwestern counties.
- July 5 Some larvae still feeding in Oneida County.
- July 4 Massive moth flight in Washburn County.

BASSWOOD



Basswood Thrips -
Thrips calcaratus
 Uzel

Populations were reduced in the northeastern counties but increased in the northwestern counties where moderate to severe defoliation was observed (Fig. 5). The first observation of significant defoliation in Polk County was made in 1989. Some branch and tree dieback was observed in Forest and Rusk counties.

Moderate to heavy defoliation of basswood was reported in west-central Wisconsin. In the southwestern counties where most basswood is concentrated on north-

facing slopes, individual trees varied from no defoliation to 90% defoliation.

Field work was completed for the DNR - UW-Madison cooperative impact survey which was begun in 1988. The results will appear in a future publication.

Phenological Notes:

May 9: First adults on basswood foliage in Iowa and Grant counties.
 May 17: First adults observed on basswood buds in Langlade County.
 May 30: First nymphs observed on foliage in northern and southern counties.

Spring Defoliator Complex:

Linden Looper	- <i>Erannis tiliaria</i> (Harris)
Maple-Basswood Leafroller	- <i>Sparganothis pettitana</i> (Robinson)
Spiny Looper	- <i>Phigalia titea</i> (Cramer)

Defoliation by the introduced basswood thrips was quickly followed by feeding by these loopers and several unidentified leafrollers which were defoliating aspen and oak as well. Damage was most evident in Clark, Chippewa and Dunn counties. In early June many basswood had less 20 percent of their normal foliage.

BALSAM FIR

Balsam Fir Sawfly - *Neodiprion abietis* (Harris)

Light defoliation of planted balsam was reported in Oneida County. Scattered defoliation of black and white spruce occurred in Burnett County.

Spruce Budworm - *Choristoneura fumiferana* (Clemens)

No defoliation was reported anywhere in Wisconsin.

Reports were received of billions of budworm moths covering the surface of Lake Superior in July. These presumably were blown from the widespread heavy infestation in Northern Ontario.

Egg mass surveys in Washburn, Bayfield, Ashland, Iron and Sawyer counties revealed no egg masses.

Balsam Gall Midge - *Paradiplosis tumifex* (Gagne)

Populations were generally very light statewide with a slight increase in numbers of galls reported in Langlade County.

Balsam Twig Aphid - *Mindarus abietinus* (Koch)

Very light populations were reported in Langlade and Oneida counties.

Winter Injury.

See Christmas tree report.

BIRCH

Birch Leafminer - *Fenusa pusilla* (Lepeletier)

Extremely heavy browning of ornamental birch foliage occurred in scattered locations statewide. Noticeable mining of white birch in forest stands occurred in several northern counties.

Bronze Birch Borer - *Agrilus anxius* Gory

Mortality of ornamental birch was common statewide. Heavy mortality of forest-grown white birch occurred in many areas in the northwestern and west central counties.

Yellow Birch Dieback - Unknown

No progression of dieback was observed in Florence County, northeastern Wisconsin. Dieback present in 1988 seemed to be the same in 1989. A few scattered sawlog-sized trees died in Florence County.

BUTTERNUT

Butternut Canker

- *Sirococcus
clavigignenti -
juglandacearum*
Nair, Kostichka
and Kuntz

There were no new county reports of butternut canker in 1989. The known county distribution is shown in Figure 6. A project to determine if resistant butternut trees can be developed was initiated by the U.S. Forest Service, North Central Forest Experiment Station. Butternut trees in Wisconsin that appear to show resistance to this disease were located and scion wood will be collected from these trees to establish clonal lines of apparently resistant trees.

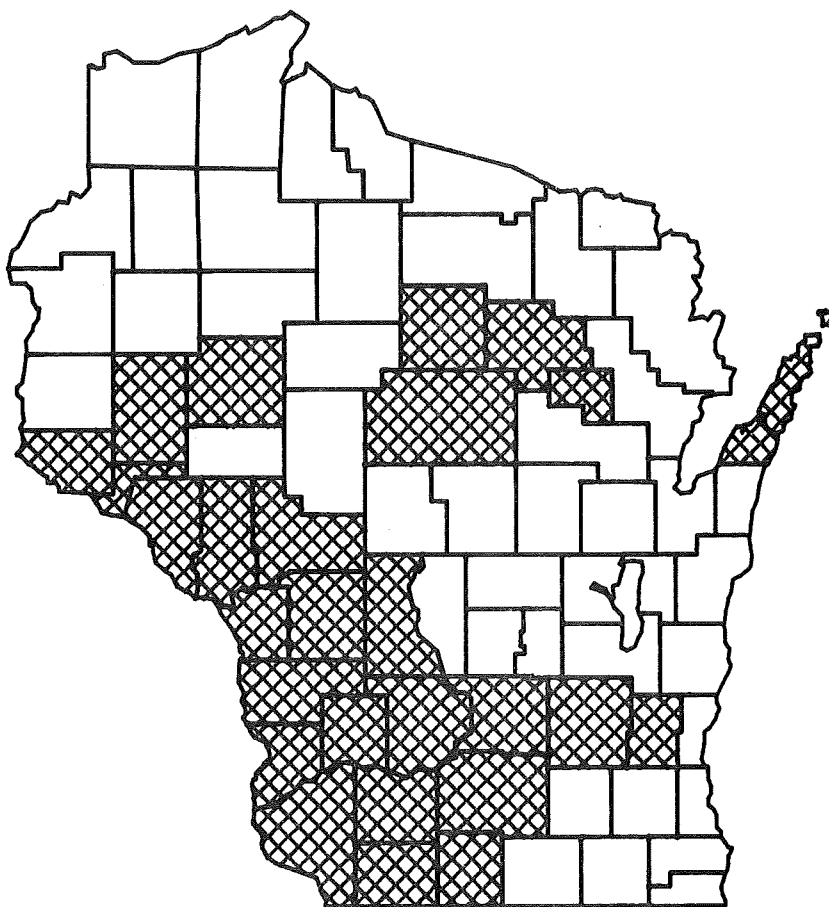
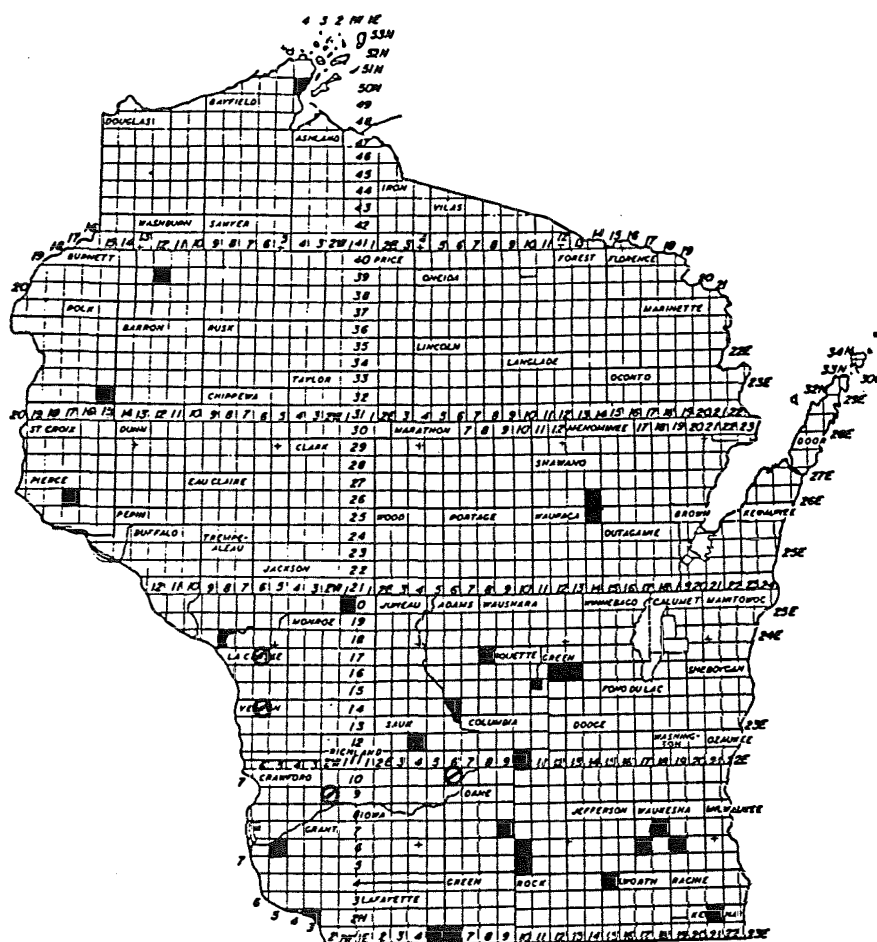


Figure 6. Known county distribution of Butternut Canker - 1989.

CHESTNUT



Chestnut Locations = ■ Chestnut Blight Locations = ⊘

Figure 7. Township locations of Chestnut and Chestnut Blight - 1989.

Chestnut Blight -
Endothia parasitica
(Murrill)
Anderson and
Anderson

A 60-acre mixed hardwood and chestnut stand in LaCrosse County continued to be the focus of chestnut blight surveys. Five infected trees and an infected stump sprout were found in 1989 in an area where diseased trees had previously been identified, cut, and buried. In 1989, three trees (one single

stemmed tree and one tree forked at the base to form two trees) with cankers above the root collar region were marked to be cut and removed or destroyed. Three trees (one single stemmed tree and one tree forked at the base to form two trees) with root collar cankers were marked for mounding with a mix of soil and manure over the cankers to arrest the growth of the fungus. A survey of this property is planned for early 1990. The objectives of the survey will be to determine disease incidence on the 60-acre property. Knowing disease incidence and location of infected trees will help determine the best disease management strategy.

In southwestern Wisconsin, northwest Vernon County, (T14N, R6W, Section 3), chestnut blight was observed on three American chestnut trees, all more than 20 inches in diameter. The trees are on private property as part of a yard and old nursery. This is the fourth location in Wisconsin of confirmed chestnut blight (Figure 7).

CHRISTMAS TREES

Cyclaneusma Needlecast - *Cyclaneusma minus* (Butin) DiCosmo, Peredo and Minter

Defoliation of two- and three-year-old needles was common on Scotch pine in central Wisconsin. Samples from these trees indicated *Cyclaneusma* had infected some of the needles but much of the needlecast was probably a result of drought stress.

Drought

Premature defoliation of two- and three-year-old needles on Scotch pine was evident on dry sites. White pine Christmas trees in central (Waushara and Waupaca counties) and western (Jackson County) Wisconsin also lost their two-year-old needles prematurely. Needle loss on white pine was most evident on the tree tops and on the south and southwest sides of the trees.

Pales Weevil - *Hylobius pales* (Herbst)

Increased flagging of white pine twigs was noted over wide areas of southern Wisconsin.

Very heavy damage to 6-foot white pine Christmas trees occurred in Columbia County where some trees had been harvested during the previous two years.

Diplodia Shoot Blight and Canker - *Sphaeropsis sapinea* (Fr.) Dyke and Sutton

Wilting and browning of the terminal whorl of shoots of Scotch pine were common throughout central (Waushara County) and southern (Dane County) Wisconsin in June. *Sphaeropsis sapinea* was isolated from the shoots. Symptoms included a brown lesion on elongating terminal shoots followed by drooping and browning of the affected shoots. Infections were scattered throughout plantations. Three plantations were surveyed in September and October and no spread of disease was observed within or between trees. Trees with infected terminals that had been sheared looked almost normal as new terminals took over to replace the diseased ones. It is still unclear what role *S. sapinea* played in this problem. Drought stress or pine spittle bugs have previously been associated with *Diplodia* shoot blight on Scotch pine. In two plantations, no inoculum source was apparent; in one plantation, an infected jack pine windbreak was probably the source of inoculum.

Cytospora Canker - *Leucostoma kunzei* (Fr.) Munk

Cytospora canker was identified on balsam fir in Marinette County, northeastern Wisconsin, and Douglas fir in Ashland County, northwestern Wisconsin. Infection was light in both counties. Insect wood borers were commonly associated with the cankers as secondary invaders. Drought stress probably predisposed the trees to infection.

White Pine Blister Rust - *Cronartium ribicola* Fisch.

Heavy infections were observed in a stand of white pine on a ridgetop in LaCrosse County on the Coulee Experimental Forest, western Wisconsin.

Pine Gall Rust - *Cronartium quercuum* (Berk.) Miyabe ex Shirai f. sp. *banksianae* Burdsall & Snow.

Galls were collected from Scotch pine in Waushara County in early June and their spores were analyzed for identification of the rust species (eastern gall rust or western gall rust). All galls were caused by eastern gall rust *Cronartium quercuum* f. sp. *banksianae*.

CHERRY

Eastern Tent Caterpillar - *Malacosoma americanum* (Fabricius)

Numbers of tents was considerably lower in the central and southern counties from the previous years extremely high levels although scattered heavy concentrations occurred in Dane, Jefferson and Rock counties.

The numbers of tents remained generally high in the northern counties but at somewhat reduced levels in the northeastern and western counties.

LARCH

Larch Needlecast - *Mycosphaerella laricina* (Hartig) Neg.

European larch (4-5 feet tall) on the Coulee Experimental Forest in LaCrosse County, western Wisconsin, showed symptoms of infection in late July. Moderate defoliation occurred. Neighboring European larch, 40-50 feet tall were apparently unaffected as were neighboring tamarack and Japanese larch. Researchers with the U.S. Forest Service, North Central Forest Experiment Station completed a study of disease resistance to *M. laricina*. Their results showed that Japanese larch exhibited excellent growth and disease resistance. Tamarack was partially defoliated but has not been defoliated in natural stands outside of the test areas. European larch showed different levels of defoliation depending on the seed source. European larch seed from Poland and the USSR exhibited excellent growth and disease resistance (M. E. Ostry and T. H. Nicholls, 1989. Screening Larch for Resistance to *Mycosphaerella* Needlecast Disease. Northern Journal of Applied Forestry, 6:4, 172-174.)

Larch Needlecast - *Meria laricis* Vuill.

All European larch plantations on the Flambeau River State Forest, Sawyer County, northwestern Wisconsin, were surveyed for the presence of larch needlecast. Three plantations were observed that had trace levels of infection by *M. laricis*. One plantation was chosen for a disease incidence and impact survey. In September, 34 percent of the trees in the one plantation surveyed were infected with *M. laricis*. Within trees, all infections were light or trace and no defoliation from infection was observed.

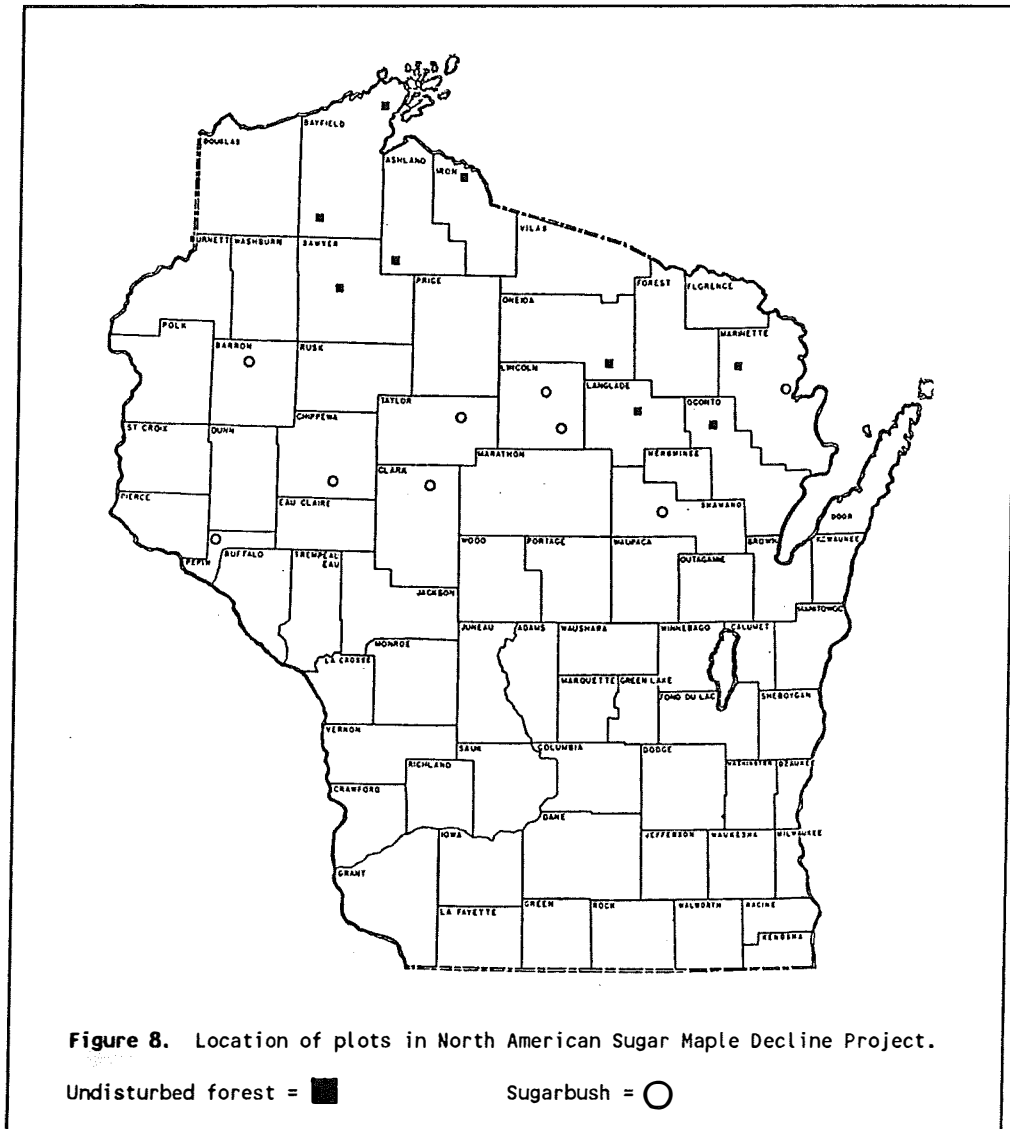
Larch Sawfly - *Pristiphora erichsonii* (Hartig)

Heavy defoliation of European larch was reported in Forest County. Very light populations were reported in Clark and Polk counties.

MAPLE

Pear Thrips - *Taeniothrips* *inconsequens* (Uzel)

The first Wisconsin report of this pest of maple was made by Dr. Ken Raffa of University of Wisconsin, Department of Entomology. The identification was confirmed by S. Nakahara, USDA, Beltsville, Maryland. The pear thrips were discovered in basswood foliage samples that were collected from a basswood thrips impact study plot in Grant County. There are scattered sugar maples in the plot.



Maple Petiole Borer - *Caulocampus acericaulis* (MacGillivray)

After a minor flareup of reports of maple damage in 1988, the population declined this year; no reports of damage were received.

Sugar Maple Decline Surveys - North American Maple Decline Project

Wisconsin is participating in the North American Sugar Maple Decline Project, administered by the U.S. Forest Service and Canadian Forestry Service. Eighteen plots were established in Wisconsin in 1988, nine in stands being tapped for maple syrup and nine in forest stands not tapped for maple syrup (Figure 8). Data were collected on the plots in 1988 and 1989 to monitor vigor, dieback, discoloration, dwarfing, and transparency. Data will be collected in 1990 and a report will follow.

NURSERY

White Pine Seedling Root Rot - *Fusarium oxysporum* Schlecht.

This disease continues to be present in Wisconsin's forest tree nurseries. Disease incidence was moderate to severe at Hayward Nursery, Sawyer County, northwestern Wisconsin. The diseased stock will be sorted and culled in the 1990 spring lifting season.

The U.S. Forest Service has initiated a study of disease epidemiology at Wilson Nursery, Grant County, southwestern Wisconsin. Disease development and its relationship to moisture stress is the primary factor being studied. Plots were set up in 1989.

OAK

Oak Wilt - *Ceratomyces fagacearum* (Bretz) Hunt

Oak wilt continued to cause mortality in the southern two-thirds of Wisconsin (Figure 9). Especially hard hit were parts of Chippewa County where much of the mortality was associated with woodland disturbance such as new home construction.

Oak mortality from the two-lined chestnut borer made surveys of mortality from oak wilt difficult. Detailed surveys were conducted in eastern Marinette County and southern Menominee County. In Marinette County, four new infection centers were observed (Figure 10). A project to control all the oak wilt with-

in one mile of the Menominee River in eastern Marinette County was initiated in 1989. Two oak wilt pockets were trenched in December, 1989, and the remaining 12 to 15 will be trenched in August, 1990. After trenching, plans are to herbicide or remove infected trees to eliminate the source of inoculum. In Menominee County, one new infection center was observed and four-old infection centers had newly wilting trees. Control through root graft severing and tree removal is also being conducted in Menominee County. A history of the oak wilt control project in Menominee County is summarized in Appendix A.

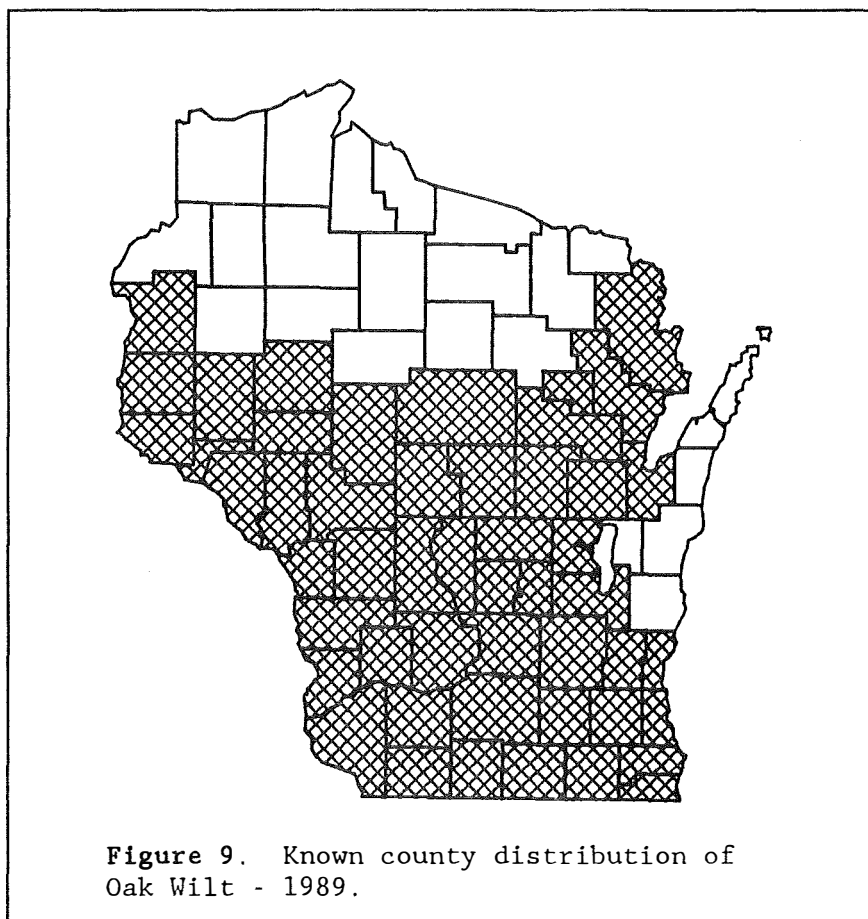
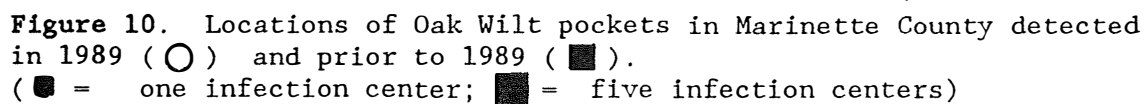


Figure 9. Known county distribution of Oak Wilt - 1989.



Fall Cankerworm - *Alsophila pometaria* (Harris)

Defoliation of oaks and other hardwoods decreased in Columbia, Dane and Jefferson counties and increased in Marquette, Green Lake and Portage counties. The counties heaviest hit were Columbia, Sauk and Marquette. Many of the heavily defoliated oaks were killed in late summer by two-lined chestnut borer.

Walkingstick - *Diapheromera femorata* (Say)

Light to moderate defoliation was observed on scattered oak sites in Marinette County.

Post Oak Locust - *Dendrotettix quercus* Packard

Moderate to heavy midsummer defoliation of black oak occurred in southwestern Clark and neighboring Jackson counties. Especially hard hit were oaks left standing in aspen clearcuts.

Twolined Chestnut Borer - *Agrilus bilineatus* (Weber)

Oak mortality skyrocketed in many areas. In Adams, Columbia, Marquette and Green Lake counties, oak mortality doubled in areas that were heavily defoliated in the spring by the fall cankerworm.

In Menominee County, 487,900 board feet of borer-killed oak was scheduled for harvest in the areas treated for forest tent caterpillar. Additional mortality was noted but was not economically salvageable.

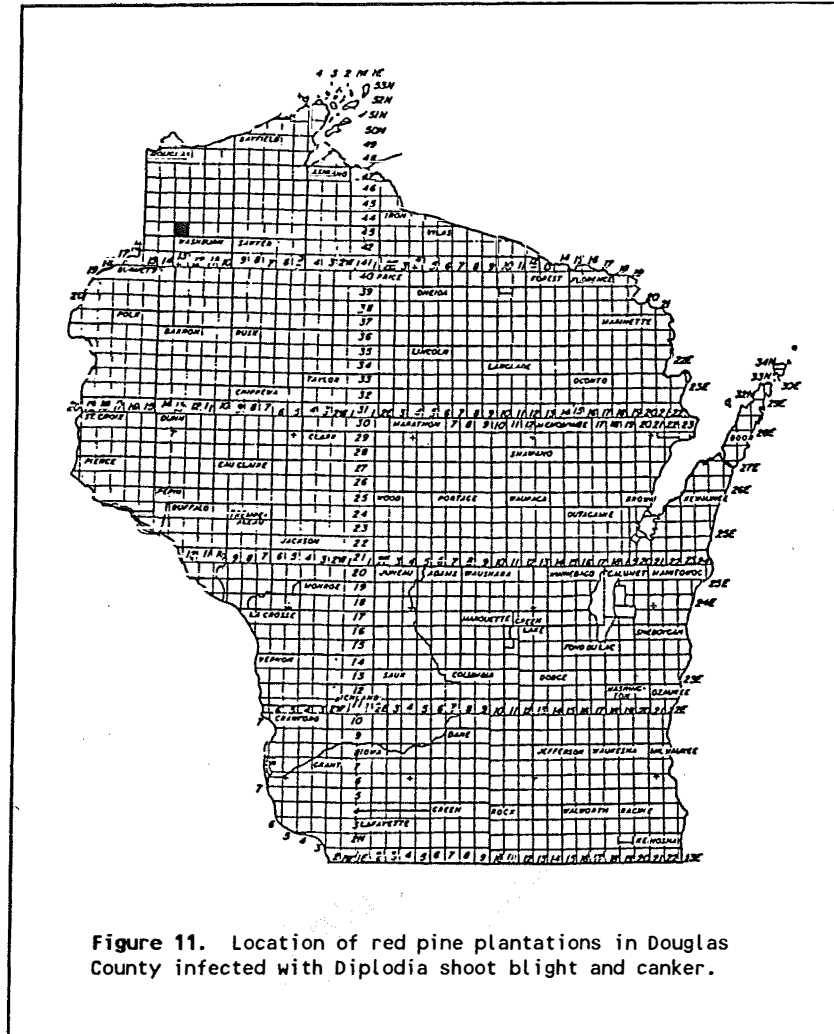
Areas of heavy mortality occurred in Douglas, Washburn, Sawyer, Polk and Burnett counties. Widespread mortality of 50 to 70 percent occurred in scrub oak stands in southern Douglas County. Young oaks defoliated by the forest tent caterpillar in Sawyer and Washburn counties suffered almost total mortality.

Scattered dead oaks were common throughout Westcentral Wisconsin. Heavy mortality occurred in disturbed sites including logging and construction sites.

Twig Dieback - *Botryosphaeria quercuum* (Schwein.) Sacc.

Twig dieback of pole and sawtimber-sized black and red oak was frequently observed along Highway 73 and County Highway Z in Wood County. Symptoms included lesions and small cankers on twigs and small branches which caused wilting and browning of fully expanded leaves. This flagging is similar to that caused by the oak twig pruner and cicada. Pynidia developed in the bark lesions and were frequently observed on affected twigs.

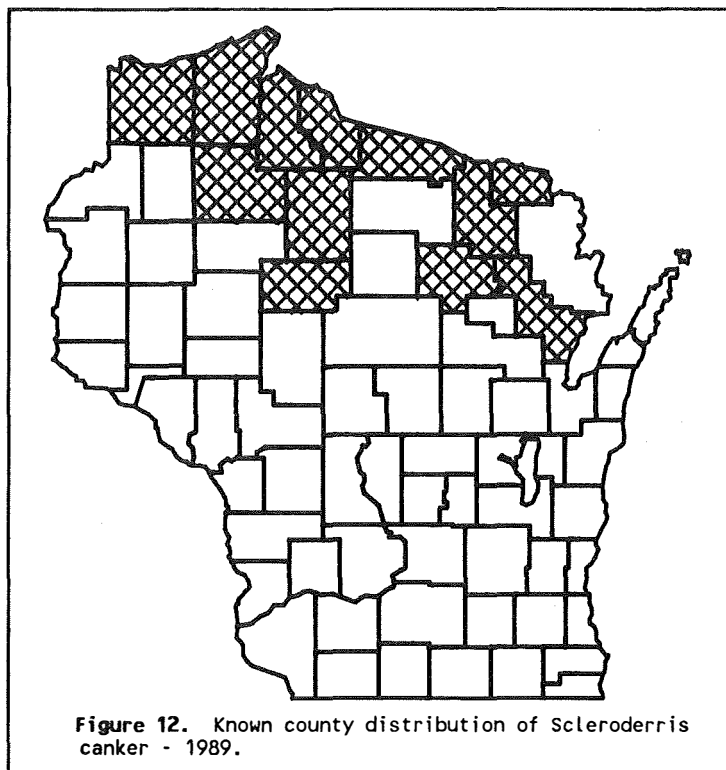
PINE



Diplodia Canker and Shoot Blight -
Sphaeropsis sapinea
 (Fr.) Dyke and Sutton

Diplodia shoot blight and canker have been present for several years in Douglas County, northwestern Wisconsin. A 120-acre red pine plantation on county forest land (T43N, R13W, Section 31, SWSW) was heavily infected in 1989. A cooperative survey project between the U.S. Forest Service and DNR forest pest management to determine disease incidence and within tree disease development was initiated. In November 1989, approximately 60 percent of the trees surveyed were diseased. In another area of the Douglas County forest, (T43N, R13W, Section 29), approximately 35% of the red pine in a 10-year-old plantation were infected.

Diplodia infected red pine windbreaks were removed at the Wilson State Forest Tree Nursery in 1988 and 1989. This was part of an IPM program to reduce pesticide use in the nursery. Unfortunately, new infections were observed in the red pine seedlings where interior windbreaks had been removed. Inoculum was still coming from the windbreaks on the edge of the nursery and from cones left behind from infected windbreaks. A survey was conducted to identify high hazard areas that were in close proximity to remaining windbreaks. The high hazard areas may be planted to nonsusceptible species or may have to have one year of preventive fungicide spray treatment during the first growing season. In 1990, a control project will be initiated with the newly emerging red pine. Sprayed (Benomyl) and unsprayed plots will be monitored for disease incidence and mortality to determine the effectiveness of windbreak removal and the effect of potential inoculum still present in the nursery.

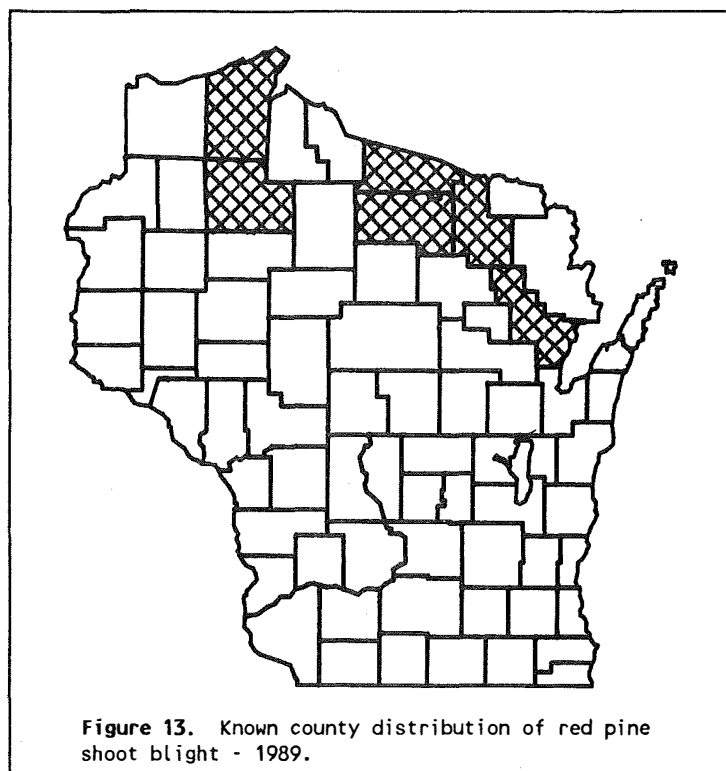


Scleroderris Canker - *Ascocalyx abietina* (Naumov) (Schlaepfer-Bernhard)

No new county locations were reported in 1989 (Figure 12). No major increase in new infections were observed in previously reported counties.

Red Pine Shoot Blight - *Sirococcus strobilinus* (Pruess)

No new county locations were reported in 1989 (Figure 13).



Jack Pine Budworm - *Choristoneura pinus* (Rohwer)

Populations remained very low; no noticeable defoliation occurred anywhere in Wisconsin. The numbers of feeding larvae slightly increased in Eau Claire and Jackson counties. A small outbreak in Vilas County disappeared.

European Pine Sawfly - *Neodiprion sertifer* (Geoffroy)

This spring defoliator caused heavy defoliation of ornamental pines in Milwaukee, Rock and Dane counties. The European pine sawfly was reported in Columbia County for the first time where it caused moderate defoliation in a small acreage of Scotch pine Christmas trees.

Redheaded Pine Sawfly - *Neodiprion lecontei* (Fitch)

Populations remained generally very light. Scattered defoliation of jack and red pine was observed in Washburn and Burnett counties.

Red Pine Needle Midge - *Thecodiplosis piniresinosae* Kearby

The damaging population in Washburn and Burnett counties declined somewhat. Light to moderate needle browning was evident on about 20,000 acres of red pine plantations in Burnett County.

Red Pine Shoot Moth - *Dioryctria resinosella* Mutuura

Midsummer attacks on new shoots were heavy on windbreaks and edges of stands in west-central, central and southwestern Wisconsin. The populations do not appear to have peaked in the west-central counties where more damage is expected next year.

Eastern Pine Shoot Borer - *Eucosma gloriola* Heinrich

Populations were very light. Some tunneling in new shoots of Scotch pine was reported in Eau Claire County.

Saratoga Spittlebug - *Aphrophora saratogensis* (Fitch)

A Vilas County population that was treated with malathion in 1988 remained below damaging levels in 1989. No damage was reported anywhere in Wisconsin.

Pine Bark Adelgid - *Pineus strobi* (Hartig)

Rising populations were noted on pines in Jefferson County. Light populations were observed on young transplanted white pine in Oneida County. Very heavy populations were reported on 25-year-old white pine in Buffalo County where the trees appeared "snow covered."

Pine Tortoise Scale - *Toumeyella parvicornis* (Cockerell)

Populations erupted in late summer in the central and west-central counties. Heavy infestations were observed on jack pine in Chippewa County and on Scotch pine in Trempeleau County. An extremely heavy population on Scotch pine Christmas trees in Waushara County was treated with diazinon.

Pine Root Collar Weevil - *Hylobius radicis* (Buchanan)

Damage to Scotch pine Christmas trees declined markedly. Very little new damage was reported anywhere in Wisconsin.

Pine Root Tip Weevil - *Hylobius rhizophagus* Millers, Benjamin and Warner

Populations declined to very low levels; no damage was reported anywhere in Wisconsin.

White Pine Weevil - *Pissodes strobi* (Peck)

Populations continue to rise in the south-central counties. Weevil attacks on sapling white pine were reported in central Richland County where they have not been seen in recent years.

Moderate damage to white pine was reported in Chippewa County.

Pine Engraver - *Ips pini* (Say)

Red and jack pine mortality was greatly reduced from last years extremely high levels. Significant mortality continued in the northwestern counties where mortality was heaviest last year.

Significant red pine mortality continued in northern Dane, Iowa and Grant counties where pole sized plantations are in weakened from two years of drought.

Phenological notes:

- May 10 - Females laying eggs in cut pine tops in Iowa and Grant counties.
- May 24 - Females laying eggs in Dunn and Eau Claire counties.
- June 7 - Callow adults present in Iowa and Eau Claire counties.

White Grubs - *Phyllophaga* sp.

Heavy grub numbers were noted on the Coulee Experimental Forest in LaCrosse County where top kill of 10-year-old European larch appeared to be related to grub feeding. Heavy grub populations were also present on a large, failed red pine plantation in Jackson County.

Plains Pocket Gopher - *Geomys bursarius*

Damage to conifer plantations decreased to low levels in the west-central counties but remained quite high in Douglas and northern Burnett counties.

Meadow Vole - *Microtus pennsylvanicus*

Severe losses occurred in Oneida County plantations of red pine owned by Consolidated Paper Company.

SPRUCEYellowheaded Spruce Sawfly - *Pikonema alaskensis* (Rohwer)

Spotty damage to spruce was reported in Oneida County while extensive heavy defoliation of open grown white spruce was observed in southern Washburn County.

Branch Abcission - Unknown

Several reports of large numbers of shoots from Norway spruce dropping in late spring were reported in Chippewa, St. Croix, and Clark counties. The likely cause was drought related.

BLACK WALNUT

Plantation
Black Walnut
Canker -
Fusarium
sporotrichio
ides Sherb.

The Wisconsin DNR and the U.S. Forest Service conducted a cooperative survey for walnut canker. Thirty plantations throughout southern Wisconsin were surveyed to determine the incidence of walnut canker on upland and bottomland sites (Figure 14).

In summary, 3,139 walnut trees were surveyed in

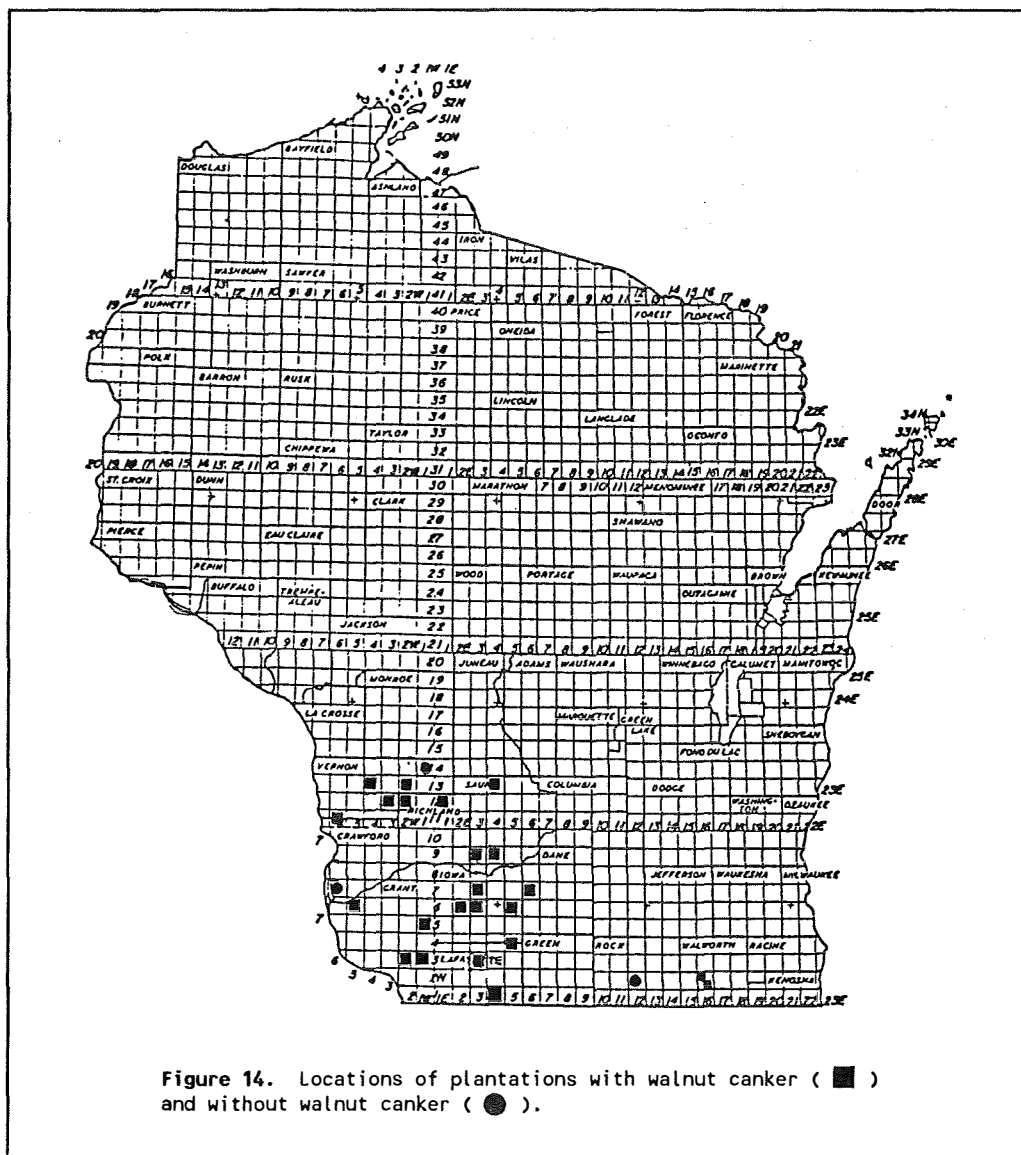


Figure 14. Locations of plantations with walnut canker (■) and without walnut canker (●).

Wisconsin; 331 trees (10.5%), were cankered. Ten percent of the trees on upland sites were cankered versus 11.1 percent on bottomland sites. Forty percent of the cankers were associated with wounds; pruning wounds and dead branches were the most common wounds associated with cankers. Ninety three percent of the cankers were located on the stem. Three samples were collected from each plantation with canker for isolation of disease organisms. *Fusarium solani* was the most frequently isolated *Fusarium* spp. Signs of ambrosia beetle were observed on only 8 of the 331 cankered trees. Iowa, Minnesota, Missouri and Illinois, also participated in the survey and sent their samples to the Wisconsin DNR for disease determination and fungal isolation. A full report is being written and will be submitted to the Northern Journal of Applied Forestry.

MISCELLANEOUS SPECIES

Gypsy Moth - *Lymantria dispar* (L.)

The number of adult males caught in pheromone traps increased tremendously from 599 in 1988 to over 5,400 this year. Egg mass surveys in Door and Kewaunee counties turned up scattered individual egg masses but no concentrations. There appears to be a general very light infestation along the Lake Michigan shore-line from north of Sturgeon Bay to south of Algoma that extends to about five miles inland. It encompasses an area of about 125 square miles.

A local infestation exists at Sister Bay in Door County. Possible infestations also exist at Two Rivers in Manitowoc County and Chenequa in Waukesha County.

The following is a summary of information provided by Wisconsin Department of Agriculture and is up to date as of October 20, 1989.

<u>County</u>	<u>Adult Males</u>	<u>County</u>	<u>Adult Males</u>
Brown	26	Milwaukee	875
Calumet	12	Oconto	6
Columbia	10	Outagamie	15
Dane	86	Ozaukee	67
Dodge	3	Portage	1
Door	2,166	Racine	63
Fond du Lac	13	Rock	2
Iowa	1	Sheboygan	78
Jefferson	14	Walworth	2
Kenosha	32	Washington	32
Kewaunee	1,394	Waukesha	186
Manitowoc	261	Waupaca	1
Marinette	64	Winnebago	<u>11</u>
Menominee	2		
		State Total	5,423

APPENDIX A

A Successful Program for the Control of Oak Wilt in Menominee County, Wisconsin.

John Hintz¹ and Jane Cummings Carlson²

Acknowledgements

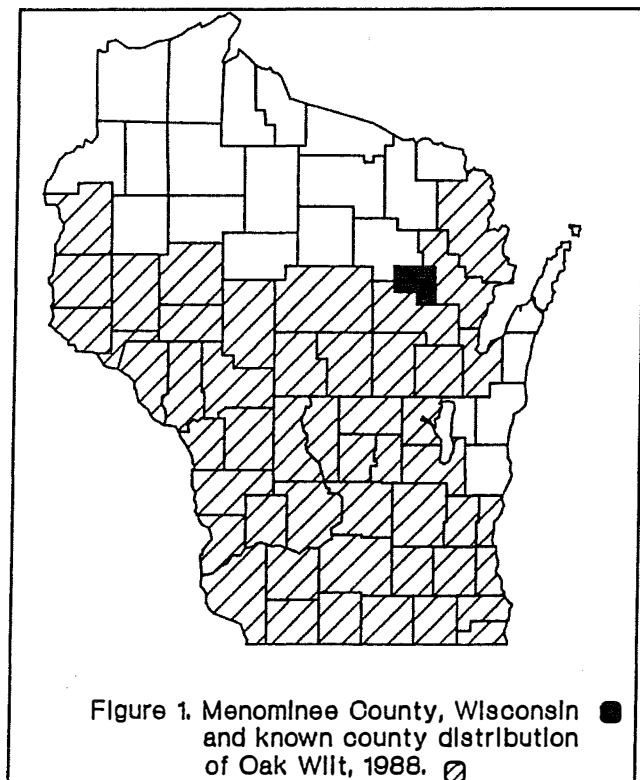
The authors wish to recognize the following individuals for their efforts in organizing the original Menominee oak wilt control program: Kenneth R. Sloan, former DNR Menominee Liaison Forester, Darrell E. Zastrow, former DNR Assistant Menominee Liaison Forester, Stanley Banash, retired DNR North Central District Forest Entomologist, and David LeMay, former Area Manager for the Legend Lake Property Owners' Association. Their recognition of the potential for effective control was instrumental in enlisting the cooperation of many agencies and people to confront the oak wilt threat while it was still a manageable problem.

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²Forest Pathologist, Wisconsin Department of Natural Resources, Madison, Wisconsin.

INTRODUCTION

Oak wilt, caused by the fungus *Ceratocystis fagacearum* (Bretz) Hunt, has killed thousands of oak trees in the southern two-thirds of Wisconsin since the early 1930s (Henry et al. 1944). Residential and park trees, farm woodlots, and forests may become infected.



Oak wilt was first observed in Menominee County, northeastern Wisconsin (Fig. 1), in 1982. An intensive oak wilt control program was implemented immediately which emphasized disease detection, trenching to break root grafts, and prompt removal of infected trees.

Within Menominee County, the disease is most prominent around Legend Lake, a 5,170 acre development in the southeastern portion of the county. The development consists of 2,710 lots, over 800 of which contain permanent homes, and several hundred acres of undeveloped land. Forest cover in the area is primarily northern pin oak, jack and red pine. The soils are sandy. Menominee County also contains 40,000 acres of commercial oak forests which contain 129,246 MBF of high quality northern red oak (Hansen, 1984).

Menominee County, the Town of Menominee, and the Menominee Indian Reservation have identical boundaries, but each is governed separately. As a result, the cooperation of several government agencies and property managers from both the private and public sectors was required to implement a control program. The extreme threat to both residential and commercial forest properties was recognized by the agencies involved.

Twenty-seven oak wilt centers have been part of this intensive control program from 1982 to 1988. This paper reports on the organization and results of the control effort.

MATERIALS AND METHODS

A step-by-step detection and control program is followed annually and outlined below. Table 1 summarizes the annual control program.

Detection, Sampling, and Analysis

In early to mid-July, the Wisconsin Department of Natural Resources (DNR) conducts an aerial oak wilt detection flight over southeastern Menominee County. Wilted trees which suggest oak wilt infection centers are marked on maps for field checking. Suspect areas reported by the public are also marked on these maps.

Following the aerial survey, DNR collects samples (twigs from freshly wilted branches) for laboratory analysis from trees at suspected infection centers. Old infection centers are checked for evidence of spread of the disease.

Sampled trees are marked with a special paper tag (Fig. 2). The tags are made of Tyvek®, a synthetic paper made by Dupont®, and are printed with Van Son ink. This paper and ink combination is tearproof, highly durable, and resists the effects of all weather extremes. The information given on the tag is intended to reduce the common problem of uninformed persons cutting and moving potentially infected trees for firewood and threatening the spread of oak wilt. Property owners on or adjacent to the lots where samples are taken are advised in a form letter of the laboratory analysis being done and measures which they can take to prevent spread of oak wilt onto or off their property. A brochure on identification and control of oak wilt (Cummings, 1986) is also distributed.

This tree is being tested for the disease

OAK WILT

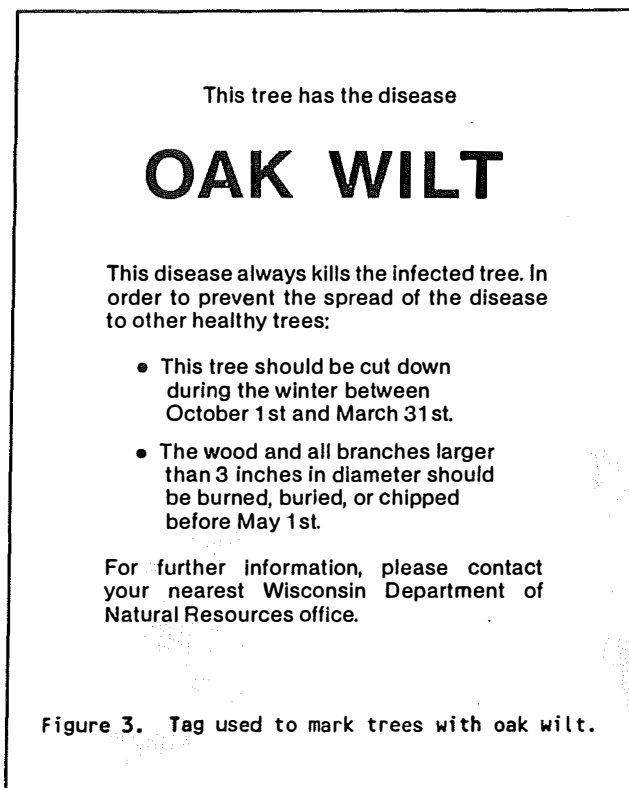
Samples have been collected from this tree and sent to the Wisconsin Department of Natural Resources laboratory for confirmation of the disease.

Sample No. _____

Date of Collection _____

DO NOT CUT BEFORE CONTACTING:

Figure 2. Tag used to mark trees to be tested for oak wilt.



Confirmation and Notification

If laboratory results are positive for oak wilt (disease present), a second tag (Fig. 3) is placed on all trees which must be removed at a given infection center. All trees that show symptoms of oak wilt (wilting, defoliation) or whose crowns spread within the dripline of infected trees are tagged for removal. This method was chosen assuming root grafts between trees with interlocking branches are likely. The area of required tree removal is extended to these apparently healthy trees to reduce the likelihood of wilt going undetected. In addition, property owners are notified that a trenching operation will need to be conducted to break root grafts through which oak wilt can spread from infected to adjacent healthy oaks.

Once all test results are known, information on new infection centers is entered into a computer file at the Menominee Forestry Center. A standard file for each infestation includes names and addresses of all involved land-owners, a map of the infestation denoting locations of structures, utility systems, and trench locations, and control measures taken. These records are updated until all necessary control measures are taken.

The computer printout showing new infection centers, and former sites still requiring control efforts, is sent to the town forester of the Town of Menominee. The town forester notifies all involved private property owners about required control activities.

The town forester acts under authority of a 1984 Town of Menominee Ordinance (Town of Menominee, 1984) written to "control and prevent the spread of injurious forest insects and diseases and provide for the protection of trees, shrubs, and plants within the Town of Menominee, Wisconsin." Acting under the direction of the town forester, state and consultant foresters may enter any private lands to sample suspect trees, mark infection centers, locate trench lines or do any other work necessary to control the spread of oak wilt.

If the town forester determines that trenching or tree removal are required for disease control on a given property, he may require the property owner to take "abatement action," at the owner's expense. A contesting landowner may appeal to a town hearing to prove the actions are not necessary. Failing this, the owner must comply with the orders of the forester, or the town will carry out the control measures and assess the costs against the property involved. In addition, a noncomplying landowner may be penalized up to \$100 and 60 days in the county jail. These penalties also apply to anyone who transports infected wood without town permission or interferes with the authorized actions of the town forester or any of his agents in the performance of their duties on private properties in the township.

Most lands (93%) within Menominee County are owned by the Menominee Indian Tribe. Federal laws which established the Menominee Indian Reservation declared that the tribe was self-governing and was not subject to state laws and any nontribal local laws. As a result, the town ordinance does not exercise any authority over tribally owned lands within the township. The majority of these tribal lands (99%) are commercial forest acreage and are under the administration and management of Menominee Tribal Enterprises (MTE). The remainder are residential properties and are administered by the Tribal Land Use Office. Both of these agencies are sent a copy of the letter to the town forester and their cooperation is requested in regard to control efforts on any lands under their jurisdiction.

Control Effects

Once property owners have been notified, arrangements to install trenches before the ground freezes are initiated. The machinery commonly used at Legend Lake is a trencher called a Ditch Witch® which is used to break root grafts (Fig. 4). Normally used to bury utility cables, it is capable of cutting root grafts to a depth of

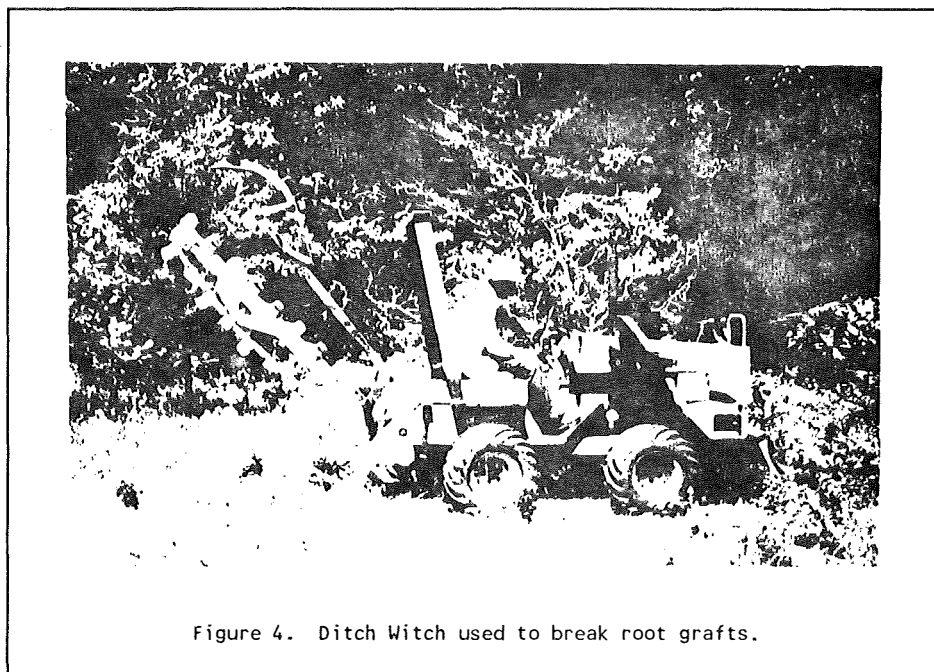


Figure 4. Ditch Witch used to break root grafts.

40 inches. The trench is about 6 inches wide and is usually filled in immediately, thereby reducing its unsightliness and potential safety hazard in residential areas. Usually, two trenches are required. The inner or primary

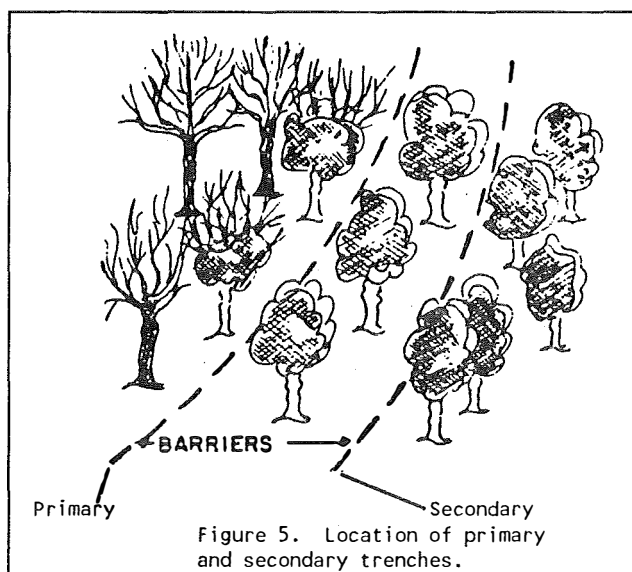


Figure 5. Location of primary and secondary trenches.

trench (Fig. 5) encircles the trees showing symptoms of oak wilt infection. A secondary trench is installed about 30 feet beyond the inner trench to serve as a second line of defense against root graft spread. This is to ensure control of root graft spread from trees that appear to be healthy but may be infected. Wherever feasible, existing utility and septic trenches are incorporated in the trenching layout.

Where applicable in commercial forest situations, chemical treatment is considered instead of trenching to kill the connecting root systems of uninfected oaks surrounding an oak

wilt pocket. In the one such infestation (Site #27), Garlon 4® herbicide in a 1 percent (v/v) concentration was used in a hand application on the stumps of trees which were removed. This application occurred in mid-autumn after MTE had cut and chipped all trees in a one acre area surrounding the infection center.

All trees encircled by the primary trench must be removed before March 1 the year following identification of oak wilt, and destroyed before May 1. These actions are required regardless of whether or not trenching was conducted on the property the preceding fall. Acceptable methods of disposing of the wood are burning, burying, or chipping. Most landowners burn the wood, or as much of it as possible considering its green quality, in wood stoves over the winter. The oak wilt tags and other literature list October 1 through March 1 as safe times of the year for tree removal, and May 1 as the latest date for disposal of infected wood. These dates were chosen to coincide with the periods when infected trees are not likely to produce pressure pads. Fungal pressure pads will generally not be formed between October 1 and April 1 in Wisconsin and insect activity will be negligible at this time. Wounds made in healthy trees by felling of infected individuals during the dormant months are not likely to become infected (Cobb et.al. 1965).

Follow-up

Early in the spring following the year of identification, oak wilt sites are checked for owner compliance with control measures. The town forester may choose to begin legal action against noncomplying landowners to ensure control measures are taken. On tribal sites, the respective tribal property administrators are notified in the event control measures are not completed and another request to initiate action is made.

Table 1. Summary of Oak wilt Control Program in Menominee Township/County/
Reservation, Wisconsin, 1982 - 1988.

Month	Control Activity
July	1. Conduct aerial detection flight. 2. Collect samples from suspect trees. Examine old infestations. 3. Mark sample trees with oak wilt tag #1. Distribute informational literature to landowners.
July through August	4. Wisconsin DNR insect and disease laboratory in Madison analyzes samples and notifies DNR office in Menominee County of results. If results are positive, all potentially infected trees are marked with oak wilt tag #2. 5. Case files begun on all new infestations.
August through September	6. Menominee Town Forester notified of lab results and status of old infestations. 7. MTE and Tribal Land Use Office notified of any Tribal properties involved.
September through November	8. Trench locations are marked and trenching is completed by the first hard frost. 9. Chemical treatments considered where applicable and applied the following year.
October through April	10. Property owners remove marked trees and dispose of infected wood by May 1. 11. DNR conducts follow-up check of new and old infestations for compliance with controls.

RESULTS AND DISCUSSION

Detection, Sampling, and Analysis

Aerial detection surveys followed by ground checks are thorough in pinpointing new infection centers. Reports of oak wilt pockets that were missed by these surveys were infrequent. Three years of defoliation by the forest tent caterpillar followed by a severe drought resulted in large pockets of dead and dying oaks in 1988 from two lined chestnut borer and *Armillaria* root rot. This made detecting oak wilt from the air difficult and required extensive ground surveys. Due to a lack of time, approximately 30 percent of these sites with dying oaks were sampled. Fortunately, only two of the twenty-five sites sampled were positive for oak wilt.

Confirmation and Notification

Occasionally, trees with oak wilt symptoms tested negative for the disease. This may be due to death of the fungus in the samples from overheating or drying out in the mail. In these sites, a "Watch" file was established and property owners were advised, but not required, to take control action. Usually, trenching is strongly recommended, but tree removal is not considered as critical. If subsequent testing proves positive for the disease, tree removal is initiated quickly, and the "Watch" file is upgraded to a standard site file. In site # 16, laboratory results were negative for two years, but the infestation was treated as a standard site because of the overwhelming presence of disease symptoms.

Citizen concern over oak wilt spread has led to increased awareness of prevention measures such as the Town of Menominee Ordinance. The DNR, Legend Lake Property Owners Association (LLPOA) and the town forester frequently receive calls from citizens and building contractors who are concerned that cutting oaks in the process of clearing land for construction might be a violation of the ordinance. These calls and calls from citizens who find oak wilt tags on their trees or receive information in the mail, have been an opportunity to educate the community about oak wilt prevention and control methods.

Control Efforts - Trenching

Twenty-seven oak wilt infection centers have been identified since 1982 (Table 2) (Figure 6). Of the twenty-five infection centers trenched, seventeen were controlled by the primary trench, three showed new infections between trenches but were controlled by the secondary trench, and three showed symptoms beyond the secondary trench, requiring a new set of both primary and secondary trenches. Success of the two centers trenched in 1988 is unknown. Three of the centers requiring additional trenching were first trenched prior to 1986. From 1982 - 1985, trenches were dug a year or more following identification of the center. This long period of time probably allowed the fungus to travel through root grafts and infect oaks beyond the proposed trench lines. By the time the trenches were dug, it's likely that new infections were already present beyond the secondary trench. Since 1986, the trenches have been dug the same year as identification of a center. This prompt control appears to be more effective since only two of fourteen pockets have required additional trenching since 1986.

Table 2. Oak wilt case histories, Menominee County/Township/Reservation, Wisconsin, 1982-1988.

Case #	Case Identified	Controls Implemented and Results	Case #	Date Identified	Controls Implemented and Results
1	12/82	Trenched in June, 1983. Infected trees removed by January, 1986. Control successful ¹ .	16	8/86	Trenched in November, 1986. Infected trees removed by August, 1986. New infections found beyond the trench lines in July, 1987 so trenched again in November, 1987. Trees removed by December, 1988. Control successful.
2	12/82	Trenched in June, 1983. Infected trees removed by January, 1986. New infections observed beyond the trench lines in 1986, so trenched again in November, 1986. Infected trees removed by March, 1987. Control successful.	19	8/86	Trenched in November, 1988. Infected trees removed by March, 1988. Control successful.
3	8/83	Trenched in July, 1984. Infected trees removed by November, 1985. New infections observed beyond the trench lines in 1985, so trenched again in September, 1985. All but three infected trees removed by December, 1985. Infections observed in the remaining three trees in 1987, but no further trenching was necessary. Remaining trees removed by March, 1988. Control successful.	20	8/86	Trenched in November, 1986. Infected trees removed by December, 1986. Control successful.
4	8/83	Trenched in July, 1985. Infected trees not removed but all died by 1986. No signs of spread through 1987, so requirement to remove trees was waived. Control successful.	21	8/86	Trenched in November, 1986. Infected trees removed by November, 1986. Control successful.
5	7/84	Trenched in July, 1985. Infected trees removed by March, 1986. New infection in one isolated tree observed between the trench lines in 1986, but no further trenching was necessary. Infected trees removed by March, 1987. Control successful.	22	8/86	Trenched in November, 1986. Infected trees removed by November, 1986. Control successful.
6	8/84	Trenched in July, 1985. Infected trees removed by December, 1986. Control successful.	23	8/86	Trenched in November, 1986. Infected trees removed by December, 1986. Control successful.
7	5/85	Trenched in July, 1985. Infected trees removed by December, 1986. Control successful.	25	7/87	Infected trees removed October, 1987 before trenching in November, 1987. Control successful.
8	8/85	Trenched in September, 1985. Infected trees removed by May, 1986. Control successful.	26	7/87	Infected trees removed October, 1987 before trenching in November, 1987. Control considered successful.
10	8/85	Trenched in July, 1986. Infected trees removed by May, 1986. Control successful.	27	7/87	Garlon herbicide applied to cut stumps of infected trees and approximately an acre of cut trees around the infection center in November, 1987. Negligible effect on sprouting, but clearcut isolated the pocket. Control successful.
11	8/85	Infected trees removed by March, 1986, before trenching in July, 1986. New infection between trench lines observed in 1986 but was isolated, so no new trenching required. Infected trees removed by December, 1987. Control successful.	28	7/87	Trenched in November, 1987. Infected trees removed by November, 1987. Control successful.
12	8/85	Infected trees removed by May, 1986. Isolated stand, so trenching not necessary. Control successful.	29	7/87	Infected trees removed October, 1987 before trenching in November, 1987. Control successful.
13	8/85	Infected trees removed by May, 1986 before trenching in July, 1986. New infections observed beyond the trench lines in June, 1987, so trenched again in November, 1987. Control successful.	33	9/88	Trenched in October, 1988. Infected trees removed by October, 1988.
14	8/85	Infected trees removed by March, 1986 before trenching in July, 1986. Control successful.	34	9/88	Trenched in November, 1988. Infected trees removed by December, 1988.
15	8/85	Infected trees removed by March, 1986 before trenching in July, 1986. Control successful.			¹ No further symptoms of oak wilt have been observed at this location as of August, 1988.

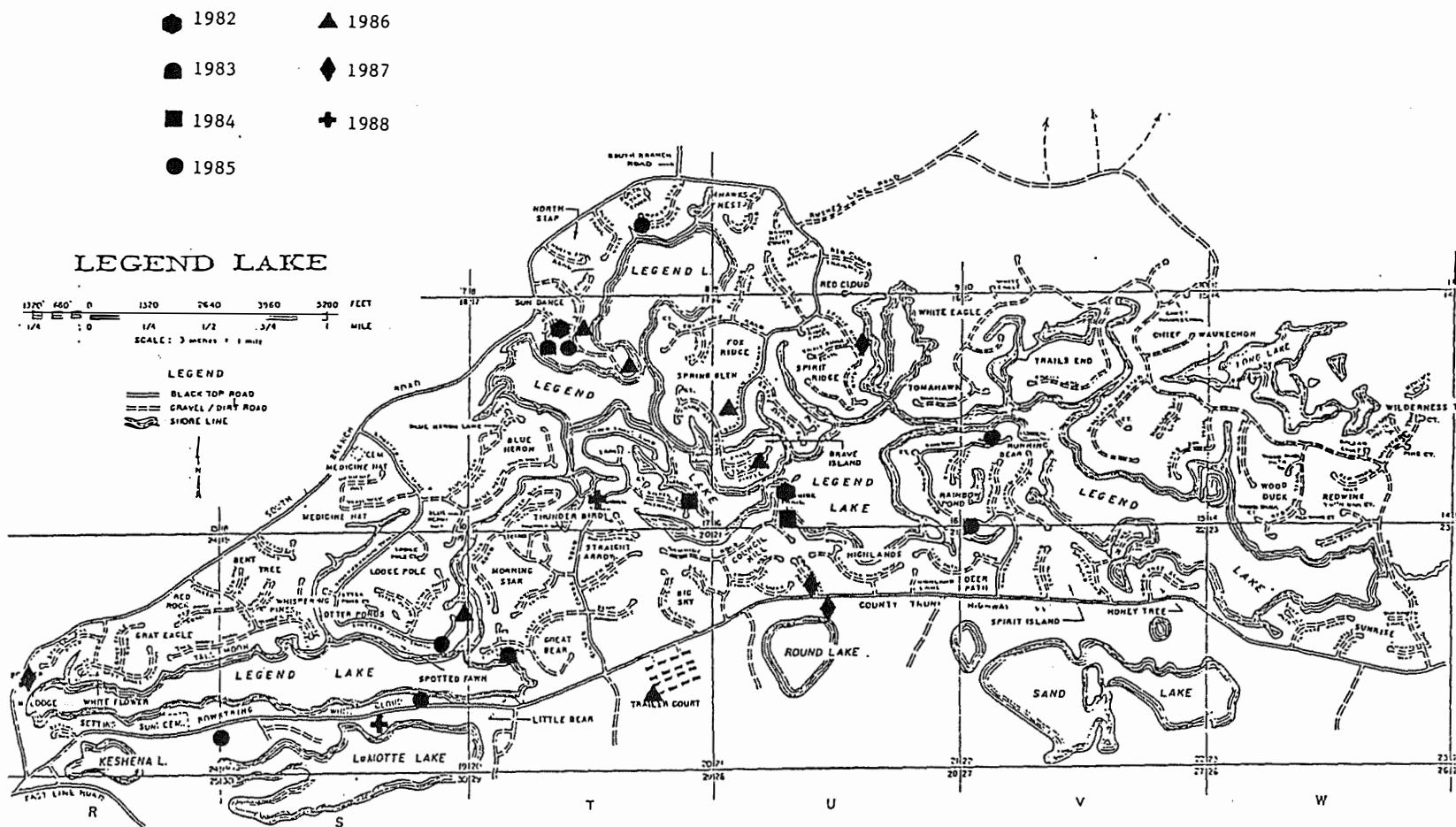


Figure 6. Location and date of identification of oak wilt infection centers in Legend Lake, Menominee County, Wisconsin.

In each of the five sites where oak wilt spread beyond the primary trench by root grafting (a breakout), the secondary trench successfully confined the spread to the area between the trench lines. In each situation, a new site file was established, and the breakout treated as a new infestation. In most sites, the old secondary trench became the new primary trench, and a new secondary trench was installed. Dead or threatened oaks between the trench lines were marked for removal. In every instance, the spread of the infestation was stopped after the second secondary trench was installed.

Site #16 provided a dramatic example of the effectiveness of the secondary trench. The area of dead trees in the 1987 breakout stopped abruptly at the outer trench (Figure 6), even though the property involved was densely covered by oaks.

When the Ditch Witch[®] was used in rocky soils or when it was necessary to cut oak roots greater than about four inches in size, trenching progress sometimes slowed to less than one-quarter its average rate (average rate = 150 ft/hr) and damage to the machine sometimes resulted. In one site, the digger chain slipped off the bar twice and the rear axle snapped due to vigorous bouncing as the 860 pound machine labored to dislodge rocks and cut heavy roots.

Prior to trenching, every reasonable attempt was made to accurately locate electric, water, telephone, and gas lines and septic systems. Occasionally, however, a utility was incorrectly located. In one site, electric service to a home was disrupted when a buried 220 volt line was cut. An LP gas line was cut at one site, and at another a buried water pipe for a sprinkler system was cut. In another site, the trencher cut into the gravel of a septic absorption field; trenching was stopped immediately and trenches relocated to avoid the septic system. In no site was anyone injured in these mishaps, and repairs were initiated immediately.

If the property requiring trenching was part of the 5,170 acre Legend Lake development, the costs of trenching were covered by the dues paid by landowners to the LLPOA. This removal of financial burden for trenching does much to ease property owners' initial objections to the control operations.

Control Efforts - Chemical and Other

Four infection centers did not require trenching. Site #27 was treated with the herbicide Garlon[®]. On this site, the success rate in suppressing oak stump sprouting was almost negligible. This was probably because the application was made too late in the growing season for effective absorption by the oak root systems. Due to the large area cleared around the infection site, this posed no immediate threat of oak wilt spread by root grafting. Since MTE wishes to replant the area to pine, the use of herbicides Velpar[®] or Round-Up[®] is being considered as a site preparation method to kill oak sprouts prior to planting. This area will be monitored to see if a secondary effect of the treatment is the halt of oak wilt spread. Site #12 involved a small oak pocket surrounded by a road, clearings, and an aspen stand; the pocket was clearcut of infected and susceptible oak and trenching was not needed. The other sites were breakouts from previous infestations and involved oak trees already isolated by trenches and natural barriers, making further trenching unnecessary.

Tree Removal and Wood Disposal

The large number of infection centers in 1985 posed a problem with disposal of infected wood. The LLPOA designated a large sand pit on the south side of the Legend Lake development for use as a central disposal facility for all oak wilt wood which property owners could not dispose of before May 1 each year. Infected trees were buried each year before fungal pad formation in May.

This disposal pit posed its own problem in April, 1986, when citizens were found taking some of the discarded wood for fire wood. A radio and newspaper campaign, combined with local law enforcement patrols of the dump site, quickly brought this to a halt, but the estimated one to two full cords of wood which were taken were not returned to the dump site. No new sites of oak wilt have been traced to the movement of this infected wood.

In some sites, property owners are not required to remove all trees surrounded by the primary trench. Site #26 was a "spider-shaped" infected area on LLPOA lands in which the primary trench line enclosed an area of over seventy trees; only those trees which wilted and died within the area enclosed by the primary trench were removed annually. This was done to temporarily reduce the aesthetic impact of the cut on the property, which lies along a main highway. In site #31 three trees were left uncut when oak wilt was identified in 1983. The landowner had already lost most of the oaks in that portion of his yard, so he was allowed to keep the oaks until they exhibited signs of disease. By 1988, all three trees had died and were removed.

Follow-Up

In ten situations, tree removal was not completed by spring of the year following detection. Seven of these situations arose before the change in policy in 1986 which required both trenching and tree removal before May 1. Complete tree removal never did occur with Site #4. The infestation involved tribally owned residential lands, which created a new jurisdiction and control problem. At the time of identification, the time frame for control measures was not clearly laid down and the Town Ordinance had not yet been passed. Without a clear control precedent, the Tribal Land Use Office hesitated to take control measures. By the time the control plan was proven effective, the trees had been dead for over two years and no longer posed a threat for disease spread, so the site file was closed. With Site #16, uncertainty regarding whether MTE or Tribal Land Use Office would be responsible for tree removal resulted in a delay. In the remaining two sites, changes in property ownership caused delays in completion of tree removal.

There are no instances where it has been necessary to resort to the provisions of the insect and disease ordinance to effect control measures.

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